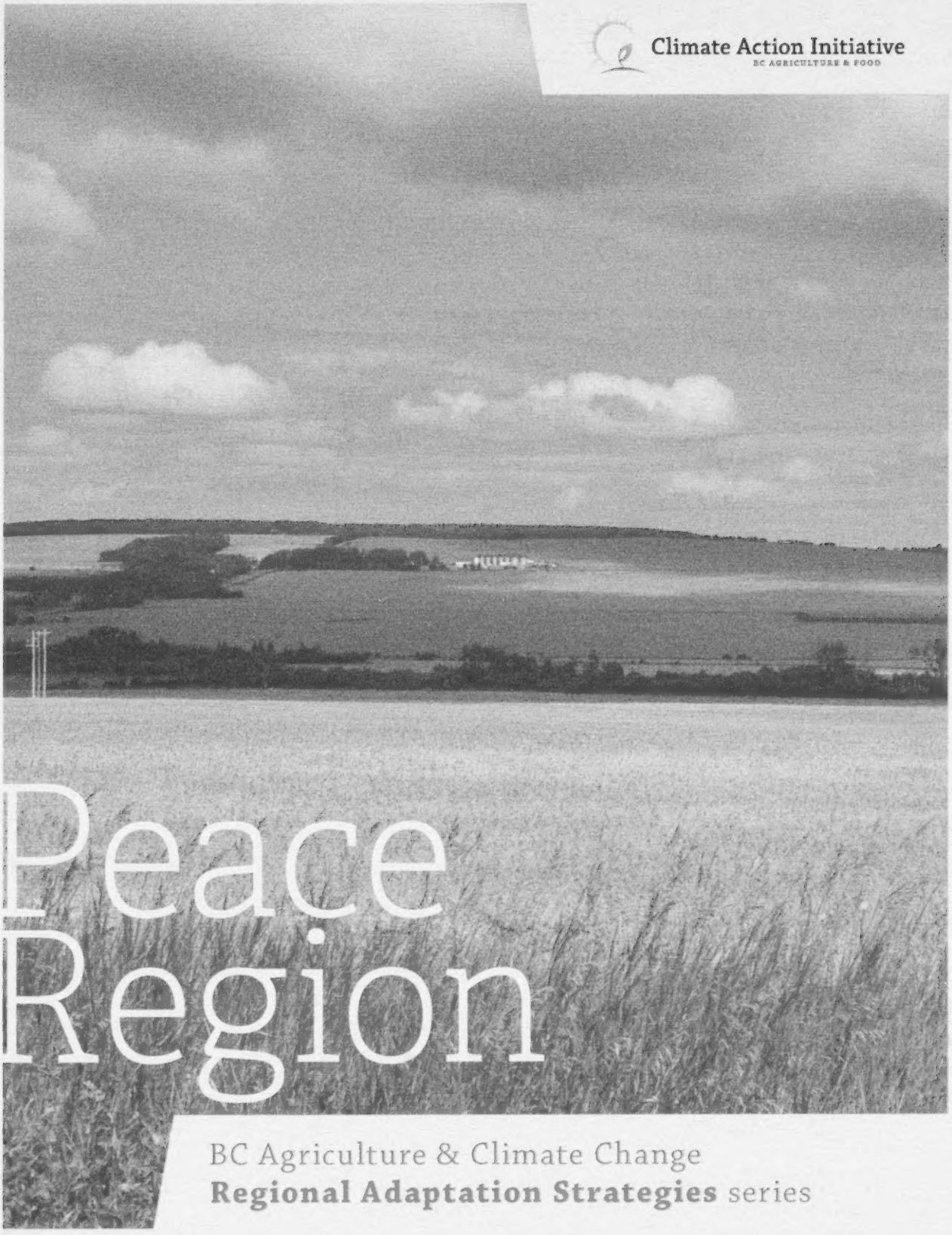

Climate Action Initiative
BC AGRICULTURE & FOOD

Peace Region

BC Agriculture & Climate Change
Regional Adaptation Strategies series

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Cover photograph of wheat and canola fields near Dawson Creek, by Mariska Richters.

Contents

1 Introduction

Project Delivery

Project Methodology

3 Regional Context

5 Regional Climate Science

Peace River Regional Climate Projections: 2020s to 2050s

Related Effects

8 Agricultural Impacts

11 Priority Impact Areas, Strategies & Actions

12 Impact Area 1
Increasing dry & drought conditions

19 Impact Area 2
Increasing precipitation & changing precipitation patterns

22 Impact Area 3
Increased variability & extremes

25 Impact Area 4
Increasing temperatures, Growing Degree Days & growing season length

29 Implementation & Monitoring

Initial Communications

Integration into the Agricultural Area Plan Process

Joint Steering Committee

Monitoring & Adaptive Management

Next Steps

33 Appendix A
Weather, Climate & Variability

34 Appendix B
Future Projections: Climate Maps & Full PCIC Tables

37 Appendix C
Definitions

38 Appendix D
Adaptive Management of Climate Change Impacts

39 Endnotes

Introduction

In the coming years, climate change will impact the agriculture sector in British Columbia in a range of different ways.

While agricultural producers are accustomed to adjusting their practices to manage through difficult conditions, the scope and scale of climate change is anticipated to exceed anything previously experienced. Adaptation will enhance the sector's resilience and capacity to manage through challenging conditions in both the immediate and long term.

In 2012, an assessment of climate change-related risks and opportunities was conducted with the agriculture sector across BC.[1] The assessment evaluated the potential impacts of climate change on agricultural production in five key regions, and explored the sector's capacity to adapt. The province-wide assessment made evident that because of British Columbia's diversity (with respect to agriculture, ecology and climate), a regional approach to climate change adaptation is required. In addition, while some adaptation will occur at the farm level, the context beyond the farm is critical for supporting agricultural adaptation. In particular, broader collaboration is required for land use, infrastructure and resource-related decision-making and action.

Building on these findings, the *BC Agriculture & Climate Change Regional Adaptation Strategies* pilot project has brought local governments and producers together to develop priority strategies and actions to facilitate agricultural adaptation to climate change. Producers, local governments and provincial government staff in each of three areas of BC — the Peace region, the Cowichan Valley region and Delta — participated in the pilot project.

The intent of the pilot project is to develop both clear actions suited to the specifics of the local context, and to encourage the integration of agricultural climate change adaptation priorities into decision-making and planning across multiple agencies and organizations. A set of agricultural adaptation strategies has been developed in each pilot area.

Project Delivery

An Advisory committee for the Peace region was formed to provide input throughout the project. This committee included participants from the Peace River Regional District, the BC Ministry of Agriculture and the agriculture sector. The agricultural producer participants volunteered their time throughout the project, representing both local production systems and agricultural organizations. The Peace River Regional District provided a written commitment to partner, providing staff in-kind (time and expertise) and covering local workshop costs. With funding from the BC Ministry of Agriculture and the Pacific Institute for Climate Solutions, the BC Agriculture and Food Climate Action Initiative provided core management and human resources for project delivery. Please see Acknowledgements for more details.

Project Methodology

The development of the Strategies involved three key stages:

- *Project Development*
  Background research was conducted and a project plan was drafted. Two initial meetings were heid with the local Advisory Committee to receive input on the project outline and the proposed approach for the first workshop.

- *Workshops*
  Two workshops were held. The first workshop focused on reviewing climate projections, discussing the associated agricultural impacts and identifying the priority impact areas. Developing strategies and actions for adapting to these priority rural areas then became the focus of the second workshop. Prior to the second workshop, a series of overarching goals, as well as possible strategies and actions, were drafted and reviewed by the Advisory Committee. These materials then helped to guide workshop discussions that focused on action planning (with local priorities, context and resources in mind).

- *Draft Strategies Document*
  Following the completion of the two workshops, background research and workshop results were compiled into a set of draft strategies and actions. These drafts were then refined and finalized, based on feedback from the Advisory committee.

photo by Mariska Richters, Dawson Creek wheat fields

Regional Context

At 119,000 square kilometres, the Peace River Regional District is the largest regional district in BC.[2] The topography of the region is varied, with mountainous areas in the south and west and the bulk of the agricultural land located in the relatively flat northeastern portion of the region; adjacent to a similarly productive agricultural area of Alberta.

The Peace region's climate is typified by long, cold winters and short warm summers. The average annual precipitation in the region is moderate, estimated to vary between 350 and 500 mm.[3] As one of Canada's northernmost agricultural areas, the Peace region benefits from long daylight hours during the summer, which allow for the production of crops requiring a high number of growing degree days. The region's growing conditions tend to support early maturing or short season crops that can perform well at lower temperatures and take advantage of long daylight hours.[4]

Just under half of the Agricultural Land Reserve area in the Peace region, about 490,000 hectares (1,210,816 acres), is defined as Class 3 or better.[5] Most of the soils are prone to water erosion and some are acidic (low pH).[6] High rates of evapotranspiration often create water deficits and dry soils in late summer, particularly in lowland areas. It is moisture availability that is defined as the primary limiting factor for much of the agricultural land in the Peace River Valley.

With approximately 831,000 hectares (2,053,446 acres) in farmland, the Peace region is the largest agricultural area in the province.[7] About 32% of the farmland in BC is located in the Peace region and about 8% of the total number of farms in the province.[8]

The economic base of the Peace region has included the oil and gas sector since the 1960s but there has been rapid growth of this industry in the past decade. There is a substantial amount of oil and gas development occurring on, or in close proximity to, the agricultural land base. This development brings resources and employment to the region, but also creates on-going impacts to the land base, water resources and farm input costs (such as local labour costs).

The primary agricultural commodities of the Peace region include grains, oilseeds, forage seed, and cattle and forage. Many producers are involved in some combination of these commodities. Overall, the Peace region produces up to 90% of BC's grain and 95% of its canola.[9] While the number of cattle has dropped in recent years, the Peace region remains a proportionally significant cattle production area in BC.

In 2010, there were 1,560 farms in the Peace region, compared with 1,729 in 2005.[10] This reduction in farm numbers may partly reflect the precipitous drop in the number of cattle operations from 550 to 255 (across BC the number of cattle operations during this period dropped by almost 27%). However, some producers may also have temporarily shifted production away from cattle. During the same period, the Peace region's acreage in canola and spring wheat increased substantially (canola area increased 37.7% to 36,000 hectares (88,958 acres) and spring wheat area increased 50.4% to 33,000 hectares (81,545 acres)).[11]

There are a number of active agricultural organizations in the BC Peace region, including the BC Grain Producers Association, the Peace River Forage Association of BC and the BC Peace River Regional Cattlemen's Association (as well as local cattle organizations). BC producers also work across the border together with Alberta producers through groups like the Peace Region Forage Seed Association. Due to the unique growing conditions of the region, a number of these organizations are involved in supporting regional research activities, although stable and sufficient funding is an on-going challenge.

The Peace River Regional District has had an Agricultural Advisory Committee in place since February of 2011. Its mandate includes providing advice to the Regional Board on matters relating to agriculture and providing a forum for focusing the concerns of agriculture in the region.[12] The Regional District recently initiated the first Agricultural Area Plan for Region and it is scheduled for completion in late 2013.

photo by Flickr's tuchodi, Fort St John

Regional Climate Science

Accessing the best possible information about climate change is a first step in determining the options for action. For many years, climate scientists have been improving and refining climate models to produce more accurate future projections. These models have now been validated against observed climate records. The resolution of the data and models continues to increase, enabling the kinds of regional projections that follow. The Pacific Climate Impacts Consortium (PCIC) is a regional climate service centre at the University of Victoria that provides practical information on the physical impacts of climate variability and change, in support of long-term planning.[13] PCIC was a key partner in developing this pilot project; assisting in the production of the agriculturally relevant, regional climate projections for the 2020s and 2050s that are presented.

Additional information about regional climate projections, maps, and related definitions may be found in Appendix B.

Peace River Regional Climate Projections: 2020s to 2050s

Key climate projections for the Peace River region in the 2020s to 2050s are summarized below. Projections are derived from PCIC's online tool, "Plan2Adapt."[14] Numbers provided are the median of all model runs (black line in the graphs), and the shaded area on the graphs shows the range of projected possible future conditions.[15]

Temperature Projections

- Annual average is 1°C warmer in 2020s (+1.8°C by 2050s)
- 9 more frost-free days annually in 2020s (+16 days by 2050s)
- 134 more growing degree-days annually in 2020s (+241 days by 2050s)

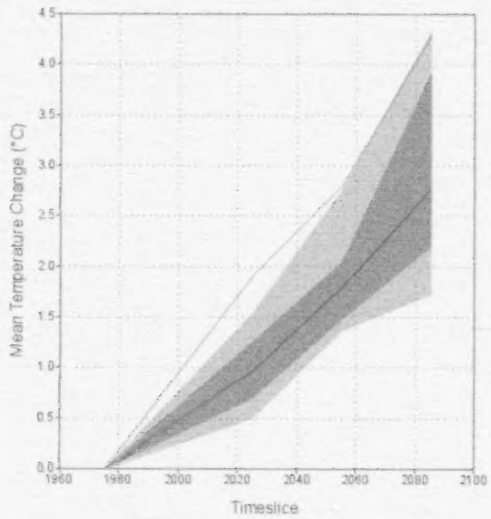

FIGURE 1 Mean Annual Temperature change, 1970s to 2080s

Temperature

As with the historical data for the Peace region, projections for key temperature variables show a strong increasing trend, with all models projecting warming in all seasons (see Figure 1, previous page).

Precipitation

While climate models show the possibility for both increasing and decreasing annual precipitation in the future, the median trend indicates a slight increase. While there is anticipated to be a slight increase in the amount of precipitation falling as snow over the winter, projections forecast a significant decrease (of around 30%) in the amount of snowfall in the spring (−55% by the 2050s). The amount of summer precipitation is about the same as the baseline — meaning there could be either a slight increase or decrease.

The distribution of projected temperature and precipitation varies across the region and is greatly influenced by local geographic settings — temperature by elevation, and precipitation by topography. As Figure 3 shows, temperatures are higher in the eastern plateau of the Peace River region, with cooler temperatures and wetter conditions in the higher elevation mountainous area to the west. Agricultural lands are primarily located in the eastern part of the region, and so would be affected by the greater temperature increases.

Precipitation Projections

- Annual precipitation: +5% (may increase) in 2020s (+8% by 2050s)
- Summer: +2% (may increase) in 2020s (+3% by 2050s)
- Winter: +5% (may increase) in 2020s (+7% by 2050s)
- Spring Snowfall: −30% (significant decrease) in 2020s (−55% by 2050s)

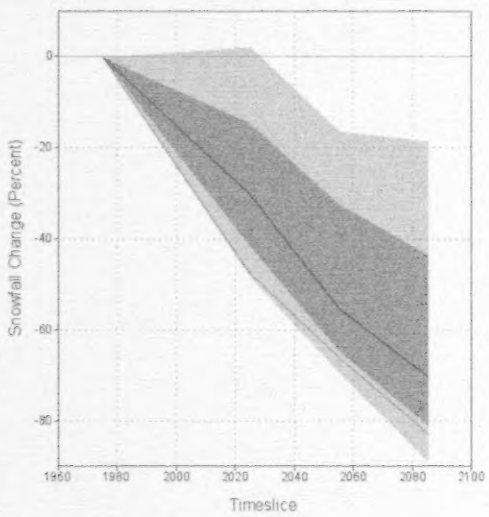

FIGURE 2 Spring Precipitation as Snow, 1970s to 2080s

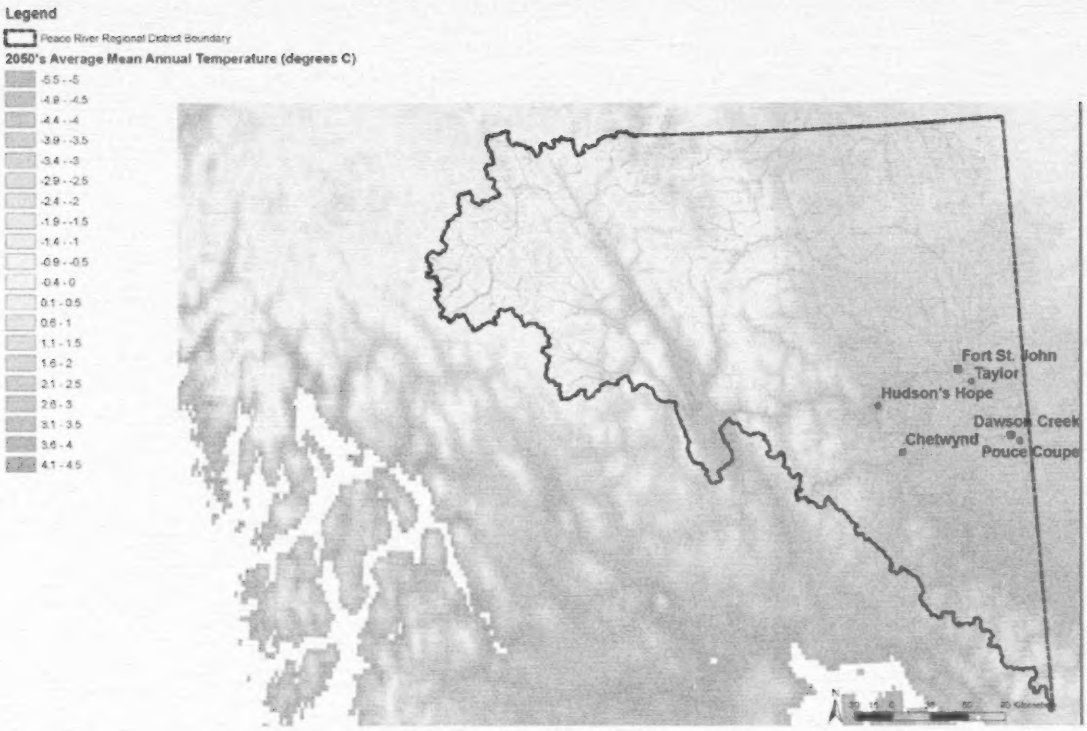

FIGURE 3 Peace River Region Mean Annual Temperature — 2050s[16]

Map illustrates the cooler mountainous region to the west, and the warmer eastern plateau where most agricultural lands are located.

Related Effects

Climate change is also expected to increase the magnitude, frequency and intensity of extreme events in the Peace River region, for both temperature and rainfall events. Extreme cold temperatures are projected to occur less frequently, and unusually warm temperatures more often. The intensity and magnitude of extreme rainfall events is forecast to continue to increase and there may be longer dry periods in the summer.

As precipitation in the Peace region increases, Peace River flows may also increase slightly. With changes to snowpack, runoff peaks may occur earlier in the season with lower discharge later in the summer.[17] In addition, the large volume, extreme events in which much of the rain will fall, are likely to cause more runoff and less infiltration of surface water into soils, potentially impacting groundwater recharge rates.

Extremes

- → More extreme high temperatures
- → Fewer extreme low temperatures
- → Longer dry periods in the summer
- → Increased intensity and magnitude of extreme rainfall

Agricultural Impacts

The changes in climate projected for the Peace River region will have a range of impacts on the agriculture sector. These impacts are summarized in the table immediately below.

TABLE 1 Potential impacts on agricultural production in the Peace River region

Projected Climate Changes	Effects	Potential Agricultural Impacts
• Increasing winter temperatures	• More frequent rain-on-snow events, freeze-thaw cycles	• *Challenging agricultural impacts:* - Increase in hazardous conditions for livestock - Increase in winterkill of grasses and legumes - Increase in management costs - Increase in loss of soil inputs applied in fall
• Increasing temperatures • Increasing growing • degree-days/heat units • Increasing frost-free period	• Increasing growing season length • Increase in wildfire risk	• *Challenging agricultural impacts:* - Increased uncertainty (shoulder season variability/extremes) - Increased risk of plant stress, pests - May decrease hay yields • *Potential opportunities:* - Increase in suitability for new varieties (forage, grain, seed) - May increase length of fall grazing season - Increase in suitability of new types of crops - Increased yields and quality

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Projected Climate Changes	Effects	Potential Agricultural Impacts
• Increasing seasonal temperatures • Decrease in precipitation falling as snow	• Earlier river peak flow • Lower water supply in summer/fall • Increasing frequency and severity of drought • Decreased quality of water supply	• ***Challenging agricultural impacts:*** - Increased plant stress - Decreased productivity - Crop losses - Increased need for water storage and irrigation - Lower pasture carrying capacity • ***Potential opportunities:*** - Decreased drying costs - Improved grain quality - Slower weed growth - Increased feasibility of storage/irrigation infrastructure
• Increasing precipitation	• Increasing moisture in the spring	• ***Challenging agricultural impacts:*** - Waterlogged soils - Increased risk of disease - Delayed planting - Increased costs • ***Potential opportunities:*** - Improved germination and emergence - May improve hay yields
• Increasing extreme precipitation events	• Flash flooding • Soil erosion	• ***Challenging agricultural impacts:*** - Crop damage - Input (fertilizer, seed, pesticides) losses - Impeded pollination - Delayed planting - Impeded combining
• Increasing variability of conditions		• ***Challenging agricultural impacts:*** - Increase in management complexity - Acceleration of cumulative impacts - Challenge to current production system - More rapid adaptations required
• Increasing winter temperatures • Increasing annual temperature • Increasing growing degree days • Increasing frost-free period	• Changes to pests and diseases: - Increased winter survival rates - Increased number of cycles in a year - Introduction of new pests and diseases • Increasing wildlife and bird activity, success rates, population sizes	• ***Challenging agricultural impacts:*** - Increased management costs, complexity, uncertainty - Crop damage, losses - Negative effects on livestock health - Increased conflicts with other stakeholders over wildlife and habitat management

This set of "impact areas" (grouping of projected climate changes and their associated effects and agricultural impacts) formed the basis for discussions at the first of two workshops. These impact areas were explored in detail with participants, and ranked in order of importance for both the individual farm and regional level. A separate risk and adaptive capacity analysis was also conducted to evaluate impact areas. This analysis considered each impact area with respect to its level of risk (likelihood & consequence) and the current ability to manage and adapt to the associated agricultural impacts.[18]

Based on these analyses, the highest priorities were identified and some impact areas in the table above were excluded from consideration at the second workshop. Those impacts that were excluded may prove to be problematic or advantageous for agriculture in the Peace region in the future, and should continue to be monitored. Adaptation strategies may still be needed for agriculture to address these excluded impact areas.

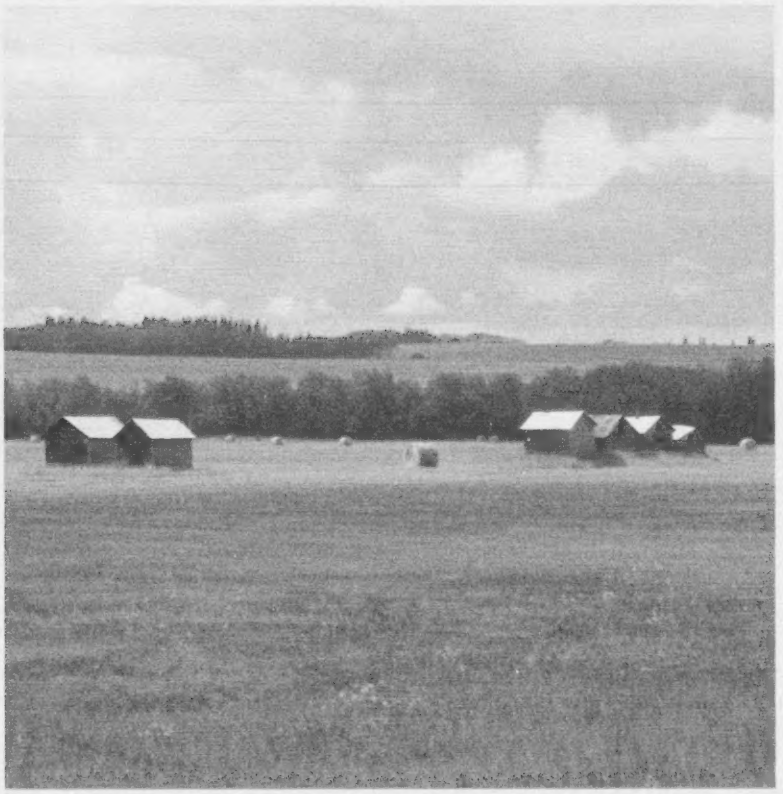

photo by Mariska Richters, near Dawson Creek

Priority Impact Areas, Strategies & Actions

The following four impact areas were identified as the highest priorities with respect to agricultural adaptation in the Peace region:

- **Impact Area 1**
  Increasing dry & drought conditions
- **Impact Area 2**
  Increasing precipitation & changing precipitation patterns
- **Impact Area 3**
  Increased variability & extremes
- **Impact Area 4**
  Increasing temperatures, Growing Degree Days & growing season length

For each of the priority impact areas, background description and adaptation goals are included. Following the description, are the strategies and actions to support the Peace region agriculture sector with adapting to climate change.

The strategies and actions presented were developed to:

- → Address the highest priority impact areas;
- → Reduce vulnerability to these impacts, and/or build capacity to adapt and respond to these impacts; and
- → Define practical steps forward that address gaps and build on existing assets in the Peace region context.

For each strategy, potential partners are identified in an accompanying text box, with possible "lead organizations" in ***bold italics***. Potential partners were identified through workshops and subsequent draft development, but there has been no formal dialogue with potential partners, or commitment, regarding their roles in various strategies and actions. Continued development of partnerships is an important element of next steps.

Potential Partners [LEGEND]

- ***possible lead organization***
- other potential partner

Following the strategies and actions, the final section outlines a plan for implementation and monitoring including immediate next steps and delivery.

Impact Area 1
Increasing dry & drought conditions

As noted previously, moisture availability is currently defined as a primary limiting factor for much of the agricultural land in the Peace River region. Climate change projections include a potential increase in overall annual precipitation, but with increasingly dry conditions in the summer and fall as more of the precipitation falls during extreme events, and evapotranspiration rates increase with higher average temperatures. In addition, precipitation falling as snow in the spring is projected to decrease by up to 55% by the 2050s, which will contribute to drier soils and less snowmelt to feed river flows later in the growing season. Increasing winter and spring temperatures may also see melt-driven peak river flows occurring earlier in the spring.

The vast majority of agriculture in the Peace region is currently precipitation and snowmelt-fed. Irrigation development has remained very limited; restricted to small areas in proximity to major rivers. Most agricultural land is located at elevations well above the river valleys, posing a technical (and economic) challenge for irrigation development.

As the variability and extremes in precipitation increase, developing alternative sources of water supply for agricultural use during dry periods will become more important. Planning and preparedness for managing through dry and drought conditions, at the sector and farm levels, will also enhance resilience.

Relevant Climate Change Effects

- → Increasingly dry conditions and lower water supply in summer/fall
- → Increased frequency and severity of drought
- → Increasing variability of conditions

The strategies and actions in this section address the following **four adaptation goals**:

- ***Increase available information regarding water resources and water use optimization***
- ***Develop agricultural water supply and distribution***
- ***Ensure ongoing water supply access for agriculture***
- ***Increase options and resources for managing prolonged dry conditions***

Establish a Regional Water Collaborative

There are growing pressures on the water resources of the Peace region, primarily due to the rapid expansion of the oil and gas industry. At present, there are a number of water-related research and planning initiatives underway, but with limited coordination among them.

Potential Partners

- ***Agricultural organizations***
- ***BC Ministry of Agriculture***
- ***BC Ministry of FLNRO***
- ***BC Oil & Gas Commission***
- ***Local governments***
- ***Peace River Regional District (PRRD)***
- ***Other relevant agencies and major water users***

The oil and gas industry is an important contributor to improving knowledge of water resources in the region. The BC Ministry of Forests, Lands and Natural Resource Operations (FLNRO) is spearheading a number of initiatives to improve water resource information and planning, and a multi-agency water planning process has recently been initiated within the provincial government. The City of Dawson Creek and partners are taking an integrated watershed management approach for the Kiskatinaw Watershed.[19]

A Regional Water Collaborative that brings together stakeholders, including industries and various levels of government, is needed to coordinate and integrate research, planning and decision-making. This would help to ensure that water resources critical to current and future agricultural productivity are protected, and that both planning and current development decisions are incorporating considerations regarding future water demand and climate change impacts. A Regional Water Collaborative also creates the potential to bridge water supply management with related runoff, storage and irrigation concerns (see Strategy 2.1).

ACTION 1.1A Develop and establish a Peace Regional Water Collaborative

i Express agriculture sector support (in writing) for establishing a Regional Water Collaborative to PRRD, local governments and BC government agencies working in the region

ii Convene potential partners to the Collaborative

iii Develop terms of reference and a governance structure

- Ensure that agriculture, and other stakeholders, are included in all stages of Collaborative development and operation

iv Identify and pursue funding and resources for implementation

Evaluate, map & monitor water resources

In order to plan effectively for agricultural water supply and access, more detailed information about the Peace region's water supply and its future (in a changing climate) is required. This background information is not only needed for agricultural water management, but also for regional level decision-making that involves all water users.

Potential Partners

- ***Agricultural organizations***
- ***BC Ministry of Agriculture***
- ***BC Ministry of FLNRO***
- Oil & Gas Commission
- ***Peace River Regional District (PRRD)***

The Peace region has relatively well developed information on historical water supply, due to a number of recent projects funded by the oil and gas industry. A newly developed hydrological modelling tool (NorthEast Water Tool — "NEWT") provides greater understanding of regional surface water resources with estimates of monthly flows for potential allocation. This tool is based on what is defined as 30 year "normal or average conditions."[20]

Groundwater resources are being assessed for the Montney gas play area around Dawson Creek, but this work has not yet been done in other parts of the region. Changes associated with the pending Water Act modernization may lead to better data availability on groundwater use. An assessment of industrial impacts on water resources is being conducted by the BC Ministry of Forests, Lands & Natural Resource Operations (FLNRO). However, there is still a need for greater integration of climate change data to evaluate potential impacts on the hydrological system.

In other parts of the province, agricultural water demand modelling has been undertaken and this is an important step in the Peace region as well. As there is currently very little irrigation in the area, water demand modelling would likely focus on possible irrigation scenarios including changes in crop types (future demand and climate scenarios). By improving understanding of demand, as well as potential for water storage and supply sources, priorities for agricultural water development may be identified. As precipitation becomes more variable, agricultural water needs are increasing in a context where there is growing pressure on limited water supplies. It will be important to better understand opportunities and barriers for secure future water access for agriculture in the Peace region.

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ACTION 1.2A **Undertake agricultural water demand modelling**	ACTION 1.2B **Evaluate priority areas for agricultural water storage and/or irrigation infrastructure development**	ACTION 1.2C **Provide regular updates about status of water resource information and planning to agricultural producers**
i Write a joint letter from the PRRD and commodity organizations to the BC Ministry of Agriculture to request that the Peace region be prioritized for a land use inventory/ water demand modelling study - Emphasize future water demand and agricultural production scenarios ii Propose that water demand modelling be incorporated as a priority in the Agricultural Area Plan	i Inventory and map existing agricultural water resources - Conduct a farm water supply and infrastructure assessment (existing sources/supplies) - Identify areas where current or future agricultural water demand is high relative to current availability (identified in Action 1.2A) - Undertake a review of water access opportunities and barriers (e.g., water licensing, regulatory drivers, competing uses) ii Identify areas with significant potential for development of water storage and irrigation infrastructure including: - Areas that could support higher value crops in future climate conditions - Areas with beneficial features for expanding or developing storage and irrigation infrastructure - link or combine with irrigation feasibility study (Action 1.4a) and runoff vulnerability study (Action 2.1b) - Fill gaps in knowledge regarding key agricultural aquifers	i Organize a workshop or informational event for producers focused on water planning and information (and invite other key stakeholders) ii Invite FLNRO staff and experts to periodically attend commodity organization meetings and provide updates - Distribute updates more broadly to producers through newsletters etc.

Enhance development of on-farm/ranch water storage

Developing on-farm water storage capacity in the Peace region will help to reduce risk and vulnerability associated with dry or drought conditions. Storage may also have co-benefits for fire protection and wildlife enhancement.

Potential Partners

- ***Agricultural organizations***
- ***BC Ministry of Agriculture***
- BC Ministry of FLNRO
- Ducks Unlimited
- Oil & Gas industry
- Peace River Regional District

A number of producers in the Peace region already utilize water storage of some kind. For example, stored water in dugouts is used for livestock, domestic purposes and crop spraying. Water storage can also assist with grazing management and productivity. The impacts of climate change will likely improve the cost-benefit equation associated with water storage infrastructure. Key considerations for increasing on-farm water storage include: the costs of development, the relationship to overall water resources and planning, and the need for improved technical information regarding climate-resilient water storage design and management.

ACTION 1.3A **Strengthen availability of technical information on climate-resilient water storage design and management (Also see Strategy 3.2)**

i Establish on-farm demonstration projects incorporating climate-resilient design (e.g., storage capacity required, reduction of sedimentation, engineering for extreme events) and provide informational resources to share findings

ii Develop improved informational and technical resources regarding water storage planning, development and maintenance

ACTION 1.3B **Enhance partnerships and funding to support agricultural water storage development**

i Enhance existing partnerships to support or co-fund development of water storage (e.g., Ducks Unlimited).

ii Investigate options for increasing or improving agricultural water storage as compensation for impacts associated industrial activity/land use

iii Seek cost-share funding for water development planning and installation

Evaluate potential for additional water supply infrastructure for agriculture

AT PRESENT, THERE IS VERY LITTLE IRRIGATION in the Peace region and there are significant economic barriers to expanding irrigation infrastructure. Nonetheless, as drier and warmer conditions become more frequent and extreme, the risks associated with dry land production in the Peace are likely to increase. Conditions in other agricultural producing regions may also increase the value of crops grown in the Peace region, and the potential for diversification to higher value irrigated crops.

Potential Partners

- Agricultural organizations
- ***BC Ministry of Agriculture***
- BC Ministry of FLNRO
- Ducks Unlimited
- Oil & Gas Commission
- ***Peace River Regional District***

The threshold for feasibility for irrigation infrastructure is not clear, and requires further investigation. Particularly the technical feasibility and costs versus the potential benefits for agriculture (e.g., risk reduction, increased yields, increased crop types/varieties etc.). Irrigation would likely also need to be accompanied by water storage infrastructure to support irrigation through the summer and/or fall when river levels drop. Information generated through Action 1.2b will directly contribute to Actions 1.4a and 1.4b.

ACTION 1.4A **Undertake cost-benefit/feasibility study of irrigation and collective water storage options for key agricultural areas**	ACTION 1.4B **Develop pilot and demonstration projects for agricultural water supply and irrigation options (Also see Strategy 3.2)**	ACTION 1.4C **Develop programming/funding to support implementation**
i Based on priority areas identified in Action 1.2B, conduct a feasibility study of new or enhanced water supply options, such as: - Potential linkages to current/proposed large scale infrastructure (oil and gas, Site C) - Shared/cooperative reservoirs - Agricultural filling stations (e.g., for sprayers) - Collective wells - Mobile water pumps and pipes - Permanent irrigation infrastructure ii Ensure that feasibility study includes consideration of future climate and production scenarios and design needs for the Peace context	i Establish priorities and pursue funding for implementation of pilot projects and demonstration ii Evaluate the effectiveness of pilots	i Identify priority options from pilots and the feasibility study ii Develop funding partnerships and pursue other sources to support implementation

Undertake drought resilience planning

While many farms in the Peace region already have experience with extended dry periods and drought conditions, these conditions are projected to become more frequent and more intense with climate change.

Potential Partners

- ***Agricultural organizations***
- Agriculture and Agri-Food Canada
- ***BC Ministry of Agriculture***
- ***BC Ministry of Environment/Inter-agency drought working group***
- Peace River Regional District

The BC government's *Drought Response Plan* provides a framework for coordinated response to drought by provincial and federal agencies, but is not specific to needs in the Peace region.[21] Developing sector and farm/ranch level planning would support increased resilience and capacity to manage through these conditions. It would also help to identify longer-term or higher cost investments that may be needed (e.g., water storage, alternate grazing or feeding systems etc). Wildfire risk may also increase during drought conditions, and risk mitigation also could be incorporated into drought management plans.

Research and demonstration focused on practices, technologies and crops to enhance resilience to dry and drought conditions are another element of adaptation, and are addressed in Strategy 3.2.

ACTION 1.5A Coordinate cross-commodity agriculture drought resilience planning and resource development

i Develop a joint working group of commodity organization representatives

ii Pool resources to develop a coordinated approach to agricultural drought planning

iii Incorporate elements such as:

- Peace-specific information for the provincial Drought Response Plan
- Localized drought monitoring—system for monitoring and communicating severity at sub-regional level
- Priorities for drought planning—increased individual farm capacity and/or broader regional supports
- Identification of key resources needed to support producers to manage dry conditions/drought (to inform below)

ACTION 1.5B Develop resources for farm/ranch level drought resilience planning

i Identify funding and/or in-kind support for resource development

ii Develop locally relevant resources and tools (workshops, informational guidebooks, extension supports etc.)

iii Deliver information and support to producers for drought resilience planning

Impact Area 2
Increasing precipitation & changing precipitation patterns

Projections for more overall annual precipitation, combined with increasing intensity and frequency of extreme precipitation events, are likely to translate into larger volumes of rain falling in single events. For agricultural production in the Peace region, extreme precipitation events are particularly problematic when combined with the projections for more extended dry periods (which are also projected to increase). The combination of drier and warmer summers with higher volumes of intermittent extreme precipitation, leads to localized flooding, runoff and erosion, as well as increased difficulty with retaining moisture in agricultural soils.

Managing increasing precipitation and extreme precipitation impacts requires integrated planning and decision-making across the land base that surrounds agricultural operations. Industrial development, particularly road construction and removal of vegetative cover, changes runoff hydrology and may exacerbate flooding and erosion on farmland. Within the Peace region, the responsibility for much of the relevant infrastructure rests with provincial agencies. Integrating climate change and agricultural impacts into decision-making about activities on the landscape, as well as maintenance and upgrades, would help to create a more effective and collaborative approach to managing runoff.

Farm level infrastructure and practices will also influence the degree to which producers are able to manage extreme precipitation events. Demonstration and piloting for managing runoff and erosion would support stronger technical guidance for producers to make-related management and investment decisions.

Relevant Climate Change Effects

- → Increasing extreme precipitation events
- → Increasing spring moisture/ precipitation
- → Increasing variability of conditions

The strategies and actions in this section address the following **adaptation goal**:

- *Mitigate effects of flooding/excess water on agricultural lands*

Develop collaborative approaches for runoff management across the agricultural land base

To effectively address the challenges associated with increasing precipitation and extreme rainfall will require a cooperative approach that brings producers into dialogue with government agencies and other private sector partners. This will also help to integrate the knowledge and experience of producers into decisions regarding new infrastructure, as well as to support cooperative approaches to resolving flooding, drainage and erosion issues that may emerge over time. Ideally this would be linked to the proposed Regional Water Collaborative (Strategy 1.1), which aims to coordinate and prioritize water management issues across agencies and stakeholders.

Potential Partners

- ***Agricultural organizations***
- BC Ministry of Agriculture
- ***BC Ministry of FLNRO***
- ***BC Ministry of Transportation & Infrastructure***
- ***Oil and gas industry***
- ***Peace River Regional District***

Ensuring that decision-making processes regarding roads and industrial development activities include considerations of climate change and agricultural impacts will facilitate prevention, rather than costly mitigation of problems after they occur. Identification of agricultural areas already experiencing, or vulnerable to, runoff-related flooding, drainage issues or erosion is an important step.

ACTION 2.1A **Strengthen collaboration for runoff management between government agencies, industry and agricultural producers**

i As part of the Regional Water Collaborative (Strategy 1.1), or independently:
- Contact potential partners with request to develop a collaborative and coordinated approach to address agricultural runoff management and climate change issues
- Develop a collaborative mechanism to increase the connection and communication regarding runoff/drainage issues
- Incorporate producer knowledge and expertise into decision-making regarding maintenance, upgrades and new development
- Integrate evaluation of climate change and agricultural impacts into approvals for infrastructure and construction practices that could alter runoff/drainage patterns

ACTION 2.1B **Identify agricultural areas vulnerable to runoff issues and implement priority upgrades**

i Identify key (and future potential) "trouble spots" for runoff/drainage on agricultural lands

ii Identify options for resolving the challenges, including possible linkages with water storage (see Action 1.2b)

iii Prioritize any necessary infrastructure investments

iv Include implementation plan

Improve available resources for on-farm runoff management

MANAGING AN INCREASE in extreme precipitation events will involve both a collaborative approach across the landscape, as well as strategic management at the individual farm level. Producers already utilize a number of practices and technologies to manage runoff and drainage in the Peace region. These include practices like conservation tillage that help to build soil organic matter/retain residues (reducing runoff and erosion) as well as infrastructure such as drainage and ditching. Some producers in the Peace region utilize surface drainage techniques such as GPS land levelling, to help prevent ponding in fields.

Potential Partners

- Agricultural organizations
- ***BC Ministry of Agriculture***
- ***Peace River Regional District***

Supporting demonstration and piloting of various practices and technologies to refine or explore new applications for practices, or to test new practices or technologies, will assist producers in determining which approaches are most appropriate to their changing conditions.

ACTION 2.2A **Pilot, evaluate and demonstrate practices for runoff, drainage and erosion management (Also see Strategy 3.2)**

i Convene partners to identify priority pilot options and funding/implementation plan

ii Pilot and demonstrate management approaches and technologies in partnership with agricultural organizations/producers (link with priority areas identified in 2.1b)

ACTION 2.2B **Provide technical and cost-share resources for on-farm planning and implementation of runoff, drainage and erosion management infrastructure**

i Integrate climate change considerations into runoff and drainage technical and extension supports

ii Actively promote farm runoff and drainage planning through workshops, programming, associations

iii Enhance cost-share supports for runoff/drainage/erosion implementation (informed by above)

Impact Area 3
Increased variability & extremes

In evaluating the risks associated with climate change, BC producers consistently identify extreme events and increasing variability in conditions as the most challenging for adaptation.[23] The uncertainty in the timing, extent and frequency of variable and extreme conditions makes it difficult for producers to plan for particular conditions; requiring instead that they maximize their ability to respond to the broad range of projected changes.

One of the most pivotal strategies for adapting is implementation of technologies and management practices that buffer production systems from a variety of potential conditions. This also means evaluating practices in a more integrated way — how they exist within farming systems and their specific environment and how climate change will shift the parameters for management.

Availability of relevant informational resources to support producer responsiveness and decision-making are critical for adapting to variability. In the Peace region there is currently limited local weather and climate data. Without this data, there are also more significant challenges in addressing the lack of agricultural pest and disease monitoring (see Strategies 4.1 and 4.2). Across such a large agricultural land base, gathering and maintaining sufficient information requires cooperative approaches, local expertise and financial resources.

Relevant Climate Change Effects

- → Overall increase in extreme weather events
- → Increased precipitation in fall and spring
- → Increased extreme rainfall events
- → Increasing temperatures
- → Increasing frequency/severity of drought

The strategies and actions in this section address the following **adaptation goal:**

- *Increase overall resilience and flexibility of agricultural systems to manage projected variable conditions*

Availability of local and agriculturally relevant weather data is limited in the Peace region at present. A relatively small number of producers have their own weather stations and many rely on the widely distributed government weather stations. These stations may be located far from a producer's micro-climate and may not collect the data that producers require for decision-making.

Potential Partners

- ***Agricultural organizations***
- BC Ministry of FLNRO
- BC Hydro
- ***BC Ministry of Agriculture***
- ***BC Ministry of Environment***
- Industry (forestry/oil and gas)

Producers require improved local weather data for immediate and near-term decisions but also to evaluate shifts occurring over time. Weather monitoring, and compilation and analysis of weather data over time, is important for informing other types of research such as assessing changes that are occurring with pests and diseases (see Actions 4.1 and 4.2), or evaluating potential crop and variety suitability (Action 4.3a).

There are public and private sector entities collecting weather data in the Peace region but this data is either unavailable to producers, or is not available in a form that is useful. Seeking partnerships to improve existing data is one option. Another is to significantly increase the number of on-farm monitoring stations and to link this data into broader data sharing networks such as Farm West or Weather Bug.

ACTION 3.1A Evaluate options for improving weather data collection and analysis (costs, timelines, long-term sustainability etc.)

i Communicate with various private and public sector entities currently collecting weather data in the Peace region — determine its accessibility and utility for producers

ii Evaluate the costs/benefits of developing additional farm weather stations and potential for linkage into existing networks

iii Determine options for generating "value-added" data products — i.e., data collection option that would best support producer decision-making and feed into other research (e.g., pest monitoring)

iv Share evaluation findings across commodity groups to select best option and develop implementation plan

ACTION 3.1B Implement selected option and ensure availability of weather data to producers

i Identify and convene key partners for implementation of plan for improving agricultural weather data

ii Secure any necessary resourcing/ funding for implementation

iii Implement preferred option

iv Communicate availability of improved weather/climate data to producers

Conduct adaptation-focused agricultural research & demonstration

Research and demonstration are important elements of supporting innovation and adaptation in agriculture. In particular, research creates an opportunity to test practices and trial varieties, while minimizing the risk for individual producers.

Potential Partners

- ***Agricultural organizations (BC and Alberta Peace)***
- ***Agriculture & Agri-Food Canada***
- Alberta Ministry of Agriculture & Rural Development
- ***BC Ministry of Agriculture***

There is a history of strong applied agricultural research in the Peace region, led in recent years by the commodity organizations with support from various partners. Research in this area has already been focused on supporting producers with adapting to changing conditions — for example, considerable research occurred in the Peace to test, refine, and promote, conservation tillage. Maintaining sufficient funding for research, demonstration and trials is an on-going challenge and climate change provides additional reason to bolster this activity.

Much of the research in the Peace region has maintained a commodity focus but with climate change there may be a growing opportunity to develop research that crosses commodity lines. Producer organizations in the BC Peace also have the option of partnering across the border with groups in Alberta's Peace region. Partnerships across the region's agriculture sector will help to support all producers to manage the impacts associated with climate change.

Some *possible* areas for research pilots, and demonstration projects include:

- → Runoff and drainage management practices/technologies
- → Erosion prevention/management
- → Water storage/irrigation infrastructure
- → Pest, disease and weed monitoring and management
- → Soil moisture retention — continued refinement of conservation tillage and other associated practices
- → Pasture management practices — resilient grazing systems
- → Forage trials (for suitability for local/changing climate conditions)

ACTION 3.2A Develop cross-commodity and cross-border adaptation research partnerships

i Canvass commodity groups in BC and Alberta Peace for interest/potential in collaborative adaptation research

ii Identify joint adaptation research priorities—building on and enhancing existing research activities where possible

iii Identify options for sustainable funding, including increasing industry contributions, to secure researchers over the longer term

ACTION 3.2B Implement pilots, trials, and demonstration activity that reflect adaptation priorities

i Undertake pilots, trials, and demonstration that reflect identified priorities

ii Host joint field days and share findings with producers

iii Maintain partnerships through regular communication and annual review of current/future research

Impact Area 4
Increasing temperatures, Growing Degree Days & growing season length

With the barrier of the mountains and its long, cold winters, the Peace region has had a natural buffer against the spread of certain pests, diseases, weeds and invasive species into the area. As temperatures warm, particularly winter temperatures, the range and prevalence of pests, diseases, weeds and invasive species is anticipated to shift. These changes may involve more favorable conditions that enable existing problem species to increase in numbers and prevalence. More challenging, from the perspective of producers, is the potential for the introduction of species into areas where they have not previously existed.

Critical to managing changes in populations and ranges of economically significant species (those that cause extensive damage to crops or harm to livestock) is monitoring what is occurring on the ground. There is an extensive monitoring network for economically significant pests across the Prairies and up to the Alberta side of the Peace region.[24] This includes weekly pest monitoring updates (as well as extensive historical records) for various important pests.

However, because monitoring stops at the BC border, this leaves producers to extrapolate from the Alberta data, or to rely on personal observation and private consultants. This does not enable broader analysis of patterns, trends and shifts that may be taking place (Prairie pest data is also cross-referenced with local weather data which is another substantial gap in the BC Peace).

Relevant Climate Change Effects

- → Increasing temperatures, Growing Degree Days and growing season
- → Increasing winter temperatures
- → Changes to pests/diseases
- → Increasing frequency and severity of drought

While changes in the distribution and prevalence of economically significant species is likely to involve management costs for producers, warmer temperatures, an increase in growing degree days and extended growing season length, may bring some advantages. The lack of certainty around these shifts means that risk is involved in testing the boundaries for different crops. However, initial experimentation may lead to longer-term, economically advantageous transitions.

The strategies and actions in this section address the following **two adaptation goals:**

- *Minimizing and managing agricultural impacts of changing pest, disease, invasive species and weed distribution and prevalence*
- *Maximizing the ability of producers to benefit from warmer temperatures and a longer growing season*

Strengthen collaboration to facilitate pest, disease, weed & invasive species monitoring and research in the BC Peace

THE GAPS IN MONITORING for agricultural pests, diseases, weeds and invasive species in the BC Peace are noted in the previous section. However, just across the border in Beaverlodge, Alberta, there is considerable research expertise through Agriculture and Agri-Food Canada staff. The Peace River Regional District also has an invasive plant specialist.

Linkages with existing resources and networks will help to maximize the value of data collected in the BC Peace. Partnerships will also be the most likely path to ensuring that a sustainable approach is developed for resourcing monitoring and data analysis over the long term.

Potential Partners

- ***Agricultural organizations***
- ***Agriculture & Agri-Food Canada***
- ***BC Ministry of Agriculture***
- Industry (forestry/oil and gas)
- Invasive Species Council (BC)
- BC Ministry of FLNRO
- Peace River Regional District

ACTION 4.1A **Convene key partners to determine the best approach for sustainable monitoring of pests, diseases, weeds and invasive species**

i Convene commodity groups and potential partners

ii Identify various options for monitoring and data analysis (e.g., producer monitoring, summer students, permanent expertise)

iii Identify sources for resourcing/funding to support best implementation options

iv Determine roles/responsibilities of partners for moving forward

v Ensure mechanism for maintaining collaboration and evaluating progress and gaps/issues over time

Implement regional data collection for pests, diseases & weeds

THE LACK OF COLLECTIVE MONITORING for pests, diseases and weeds, leaves producers in the Peace without access to information about emerging issues or broader shifts that may be occurring. The risks associated with this gap are substantial. Developing a regional monitoring system to collect data is a high priority and requires a long-term commitment to ensure that monitoring is done annually, and is effectively linked with existing resources and networks. Effective communication of information to producers is also important (the Prairie Pest Monitoring Network provides on-line weekly reports, but supplementary analysis and information distribution with a focus on BC may be needed).

Potential Partners

- ***Agricultural organizations***
- ***Agriculture & Agri-Food Canada***
- ***BC Ministry of Agriculture***
- Invasive Species Council of British Columbia
- ***Peace River Regional District***

ACTION 4.2A **Implement monitoring to collect critical data regarding pests, diseases, weeds and invasive species**

i Undertake in-field monitoring in the BC Peace region (recording what growers are producing and changing over time)

ii Develop on-going regional insect pest monitoring that is linked with weather and climate data (and linked to Prairie Network)

iii Conduct regular disease, weed and invasive species surveys—particularly in areas affected by industrial activities

iv Refine and adjust as needed

v Seek long-term funding

ACTION 4.2B **Ensure regular communication of monitoring findings**

i Ensure that producers are aware of on-line resources

ii Conduct workshops, field days and/or develop written resources, as deemed necessary, to effectively communicate on-going or emerging risks

Conduct trials for future climate-suitable crops & varieties

Some commodity groups in the Peace region already integrate into their variety trials the testing of crops or varieties that "push the margins" in the current climate. Over time, some of these crops may become increasingly suitable and there is considerable benefit in testing them in the low-risk context of collective trials. This research is undertaken with an eye to bringing new varieties and crops (with higher value, improved yields or strengthened resilience to various conditions) into the Peace region. Expanding this research by looking at crops that have not traditionally been grown commercially in the Peace area has the potential to support producers further with diversification and adaptation. Lack of irrigation is a considerable limitation in this regard; linking some trials into areas with greater feasibility for irrigation would assist in evaluating the associated potential for new crops.

Potential Partners

- ***Agricultural organizations (BC and Alberta Peace)***
- ***Agriculture & Agri-Food Canada***
- Alberta Ministry of Agriculture & Rural Development
- ***BC Ministry of Agriculture***

ACTION 4.3A **Identify promising areas of focus for undertaking trials and secure partnerships/resources**

i Conduct a scan of potentially viable/high value crops (suitable to projected climate conditions, Peace soils etc.)—look to regions with climates similar to those projected for the Peace

ii Seek out options for linkages with existing trials

iii Identify potential partners (see Action 3.2a)

iv Seek funding (see Action 3.2a)

ACTION 4.3B **Undertake trials for crops with the greatest potential and share findings**

i Test varieties/new crops in field conditions

ii Share findings with producers through field days/publications etc.

Implementation & Monitoring

While all of the actions in this document are important for the agriculture sector to adapt to climate change, the actions below are identified as "next steps" both due to their importance and/or to the relative ease of implementing them (see text box). Building momentum and capacity for collective action, and addressing the most important issues, will help to ensure implementation of all of the identified actions. Implementation considerations are identified for each of these next steps, outlined below.[25]

The Climate Action Initiative and local partners intend to form a joint steering committee to oversee implementation of the strategies. While it is understood that many partners will be involved in delivering various actions, this committee will play a key role in monitoring and taking an adaptive management approach over time (see below).

Initial Communications

The strategies and actions in this document have been developed collaboratively by agricultural producers, Peace River Regional District and provincial government staff and the Climate Action Initiative. Formation of a steering committee and implementation of this suite of actions will require cooperation and commitment across these and other partners.

The first step towards furthering this collaboration will be to communicate the results of this process to potential partners and decision-makers, such as:

- Peace River Regional District Board and Agricultural Advisory Committee
- Other local governments in the Peace region
- Provincial government agencies working in the Peace region (e.g., Ministry of Forests, Lands and Natural Resource Operations, Ministry of Enviroment, Oil and Gas Commission)
- BC Ministry of Agriculture
- Agricultural organizations in the Peace region

Important actions are those that address the highest priority impacts or critical gaps for building resilience. These may be, but are not necessarily, the most urgent actions.

Ease of implementation refers to actions that can be initiated without delay because there is a "window of opportunity," there are clear co-benefits for other actors or programs, or there are minimal barriers to address. These actions, sometimes referred to as "low-hanging fruit," are critical for turning awareness into action.

Integration into the Agricultural Area Plan Process

Specific effort will be made to integrate the results of this process into the Peace Region Agricultural Area Plan (currently under development). This will help to ensure that priorities, activities and resources are strategically focused and complement one another.

Joint Steering Committee

A joint steering committee — including representatives from organizations that were part of developing this plan — is needed to enable partners to continue to collaborate and provide input. The best "home" for this committee will be determined over the next few months. This steering committee could be part of the PRRD Agricultural Advisory Committee, or it could be an independent entity. The first step will be to determine which option will be most effective option for overseeing ongoing implementation and monitoring of the plan.

Monitoring & Adaptive Management

In addition to building the capacity for collective action, climate change adaptation requires the ability to reflect, learn and adjust course in response to developing knowledge and conditions (this is known as "adaptive management" — see Appendix D). To achieve this, regular monitoring of the plan, new knowledge and evolving conditions should be undertaken. It is suggested that this be conducted annually and include:

- Updates on climate projections and potential impacts to agriculture
- Discussion of climate-related impacts being experienced currently
- Review of progress, and barriers to progress, on plan implementation
- Revisiting priorities for action

Next Steps

Action 1.1A
Develop and establish a Regional Water Collaborative

Key roles	BC Ministry of FLNRO, BC Ministry of Agriculture, BC Oil & Gas Commission, Peace River Regional District (PRRD), other local governments, agriculture organizations
Timeframe	Mid-term (2–5 years)
Cost	Medium ($25,000–200,000)
Existing assets	Shared interest in water management; increasing resources and capacity for regional water management; industry resources
Key barriers	Complexity, cross-jurisdictional cooperation required

Action 1.2A
Undertake agricultural water demand modelling

Key roles	BC Ministry of Agriculture, PRRD
Timeframe	Mid-term (2–5 years)
Cost	Medium ($25,000–200,000)
Existing assets	Ongoing BC Ministry of Agriculture modelling work; expertise
Key barriers	Limited resources for near-future completion

Action 1.2b
Evaluate priority areas for agricultural water storage and/or irrigation infrastructure development

Key roles	BC Ministry of Agriculture, BC Ministry of FLNRO, Agricultural organizations
Timeframe	Mid-term (2–5 years)
Cost	Medium ($25,000–200,000)
Existing assets	Existing/ongoing water-related research
Key barriers	Complexity, cooperative model required, cost

Action 1.3b
Enhance partnerships and funding to support agricultural water storage development

Key roles	Agricultural organizations, BC Ministry of Agriculture
Timeframe	Short-term (< 2 years)
Cost	Low (< $25,000); funding for storage cost is High (> $200,000)
Existing assets	Organizations (e.g., Ducks Unlimited); resources from industrial development
Key barriers	Requires cooperation, partnerships, non-traditional funding models

Action 1.5a
Coordinate cross-commodity agriculture drought resilience planning and resource development

Key roles	Agricultural organizations, BC Ministry of Agriculture, BC MOE/Inter-agency drought working group
Timeframe	Short-term (< 2 years)
Cost	Low (< $25,000) to Medium ($25,000–200,000)
Existing assets	Strong agricultural organizations
Key barriers	Limited time/resources of agricultural organizations

Action 2.1a
Strengthen collaboration for runoff management between government agencies, industry and agricultural producers

Key roles	PRRD, agricultural organizations, BC Ministry of FLNRO, BC Ministry of Transportation & Infrastructure, oil and gas industry
Timeframe	Short-term (< 2 years)
Cost	Low (< $25,000)
Existing assets	Inter-agency water management work in the Peace
Key barriers	Coordination across industry and government, and incentives to mitigate impacts for agriculture

ACTION 2.2A

Pilot, evaluate and demonstrate practices for runoff, drainage and erosion management

Key roles	BC Ministry of Agriculture, Agricultural organizations, PRRD
Timeframe	Short-term (< 2 years)
Cost	Medium ($25,000–200,000)
Existing assets	Local knowledge and expertise
Key barriers	Best value achieved with an integrated approach (increases complexity)

ACTION 3.1A

Evaluate options for improving weather data collection and analysis

Key roles	BC Ministry of Environment, BC Ministry of Agriculture, Agricultural organizations
Timeframe	Short-term (< 2 years)
Cost	Low (< $25,000)
Existing assets	Existing infrastructure and analysis tools
Key barriers	Allocating resources, coordinating various data sources

ACTION 4.1

Convene key partners to determine best approach for sustainable monitoring of pests, diseases, weeds and invasive species

Key roles	Agricultural organizations, BC Ministry of Agriculture, Agriculture and Agri-Food Canada
Timeframe	Short-term (< 2 years)
Cost	Low (< $25,000)
Existing assets	Ongoing work in the Prairies (AAFC at Beaverlodge)
Key barriers	May require partnering across governments and jurisdictions

ACTION 4.2A

Implement monitoring to collect critical data regarding pests, diseases, weeds and invasive species

Key roles	Agricultural organizations, Agriculture & Agri-Food Canada, BC Ministry of Agriculture, PRRD
Timeframe	Short-term (< 2 years)
Cost	Medium ($25,000–200,000); High (> $200,000) for on-going, multi-year
Existing assets	Ongoing work in the Prairies (AAFC at Beaverlodge); priority for producers
Key barriers	May require partnering across governments and jurisdictions; access to data analysis

Appendix A
Weather, Climate & Variability

Weather is what happens on a particular day at a particular location. Farmers are continually required to adapt to weather conditions to effectively plan and manage their businesses. In contrast, climate refers to long-term trends, patterns and averages over time. These are more difficult to notice through day-to-day or year-to-year experiences, or short-term records of weather. However, over a period of decades, recorded observations can characterize the climate and identify changes.

Anyone who pays close attention to weather forecasts appreciates that predictions of weather are often limited in their accuracy. This is partly because of the many factors that impact weather. Turning to longer, climate-related timescales, in BC we are familiar with the 3–7 year cycles of El Niño and La Niña ("ENSO"), which dramatically impact the climate of individual seasons and years (see Figure 2). Compared to La Niña years, conditions in BC during El Niño years are typically warmer and drier in winter and spring, and less stormy in southern BC.

Adding to the complexity, the Pacific Decadal Oscillation (PDO) is a known pattern that shifts over longer time periods (20 to 30 years) and this is associated with different temperature and precipitation conditions here in BC. It also has a warm and cool phase, and so it can either enhance or dampen the impacts of El Niño and La Niña conditions in a given year.

Figure 6 shows the difference between climate variability, oscillations, and climate change. The many factors that impact the weather create significant variation in what we experience from year to year. However, we are still able to chart averages over long periods of time.

For additional resources see *BC Agriculture Climate Change Adaptation Risk and Opportunity Assessment Series* (*www.bcagclimateaction.ca/adapt/risk-opportunity*) and *Regional Agricultural Adaptation Strategies Technical Report* (*www.bcagclimateaction.ca/adapt/regional-strategies*).

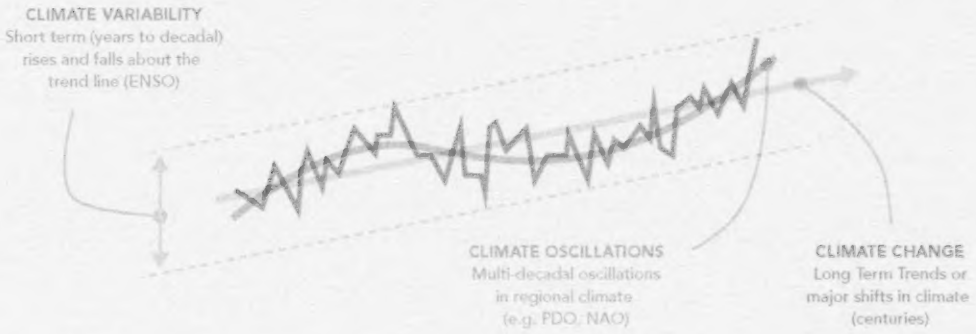

CLIMATE VARIABILITY
Short term (years to decadal) rises and falls about the trend line (ENSO)
CLIMATE OSCILLATIONS
Multi-decadal oscillations in regional climate (e.g. PDO, NAO)
CLIMATE CHANGE
Long Term Trends or major shifts in climate (centuries)

FIGURE 4 Climate Variability, Oscillations & Change

Diagram showing difference between climate variability, oscillations, and climate change. Adapted from original, courtesy of Pacific Climate Impacts Consortium, www.pacificclimate.org

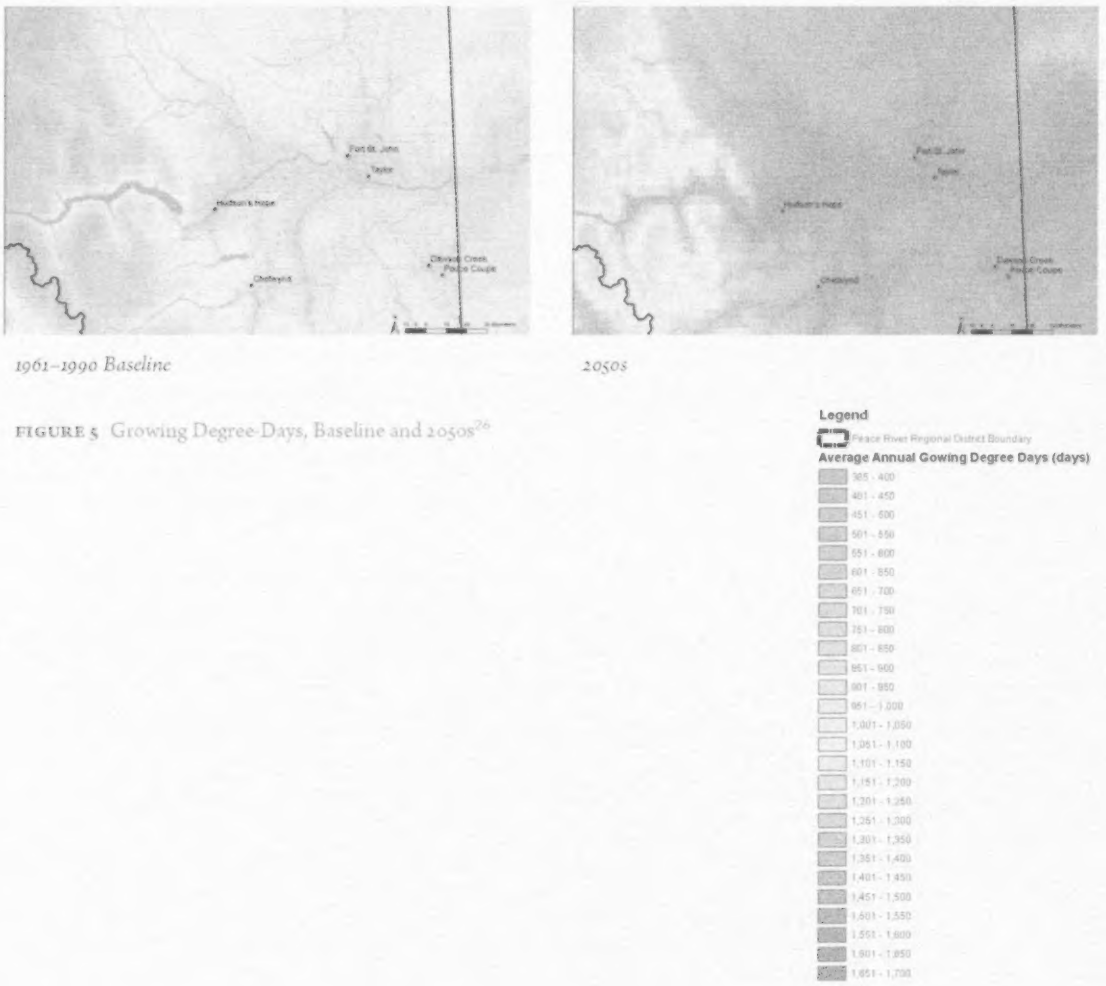
Appendix B
Future Projections: Climate Maps & Full PCIC Tables

TABLE 2 Peace River Regional District Climate Projections — 2020s

Climate Variable	Time of Year	Projected Change from 1961–1990 Baseline		
		Peace River (Range)	Peace River (Average)	BC (Average)
Mean Temperature (°C)	Annual	+0.5 °C to +1.7 °C	+1.0 °C	+1.0 °C
Precipitation (%)	Annual	–2% to +10%	+5%	+4%
	Summer	–4% to +9%	+2%	+0%
	Winter	–1% to +12%	+7%	+4%
Snowfall (%)	Winter	–1% to +11%	+5%	–2%
	Spring	–48% to +2%	–30%	–30%
Growing Degree Days (degree days)	Annual	+54 to +177 degree days	+129 degree days	+153 degree days
Heating Degree Days (degree days)	Annual	–616 to –180 degree days	–352 degree days	–354 degree days
Frost-Free Days (days)	Annual	+5 to +16 days	+9 days	+10 days

TABLE 3 Peace River Regional District Climate Projections — 2050s

Climate Variable	Time of Year	Projected Change from 1961–1990 Baseline		
		Peace River (Range)	Peace River (Average)	BC (Average)
Mean Temperature (°C)	Annual	+1.4 °C to +2.8 °C	+1.8 °C	+1.8 °C
Precipitation (%)	Annual	+1% to +16%	+8%	+6%
	Summer	–7% to +12%	+3%	–1%
	Winter	–4% to +22%	+11%	+8%
Snowfall (%)	Winter	–7% to –17%	+7%	–10%
	Spring	–69% to –16%	–55%	–58%
Growing Degree Days (degree days)	Annual	+139 to +380 degree days	+225 degree days	+283 degree days
Heating Degree Days (degree days)	Annual	–989 to –485 degree days	–651 degree days	–648 degree days
Frost-Free Days (days)	Annual	+10 to +25 days	+16 days	+20 days



1961–1990 Baseline

2050s

FIGURE 5 Growing Degree-Days, Baseline and 2050s[26]

Winter 1961–1990 Baseline

Winter 2050s

Legend

Peace River Regional District Boundary

Winter Precipitation (mm)

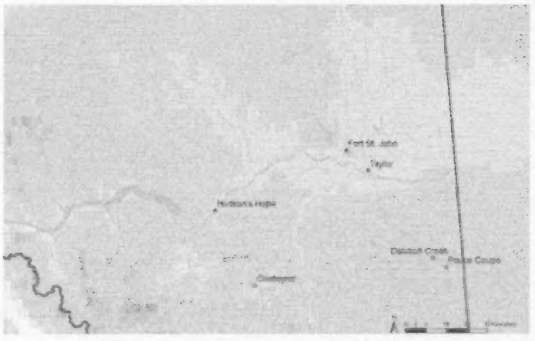
61 - 100
101 - 150
151 - 200
201 - 250
251 - 300
301 - 350
351 - 400
401 - 450
451 - 500
501 - 550
551 - 600
601 - 650
651 - 700
701 - 750
751 - 800
801 - 850
851 - 900

Legend

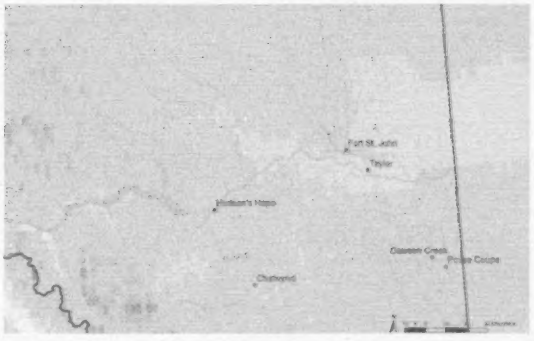
Peace River Regional District Boundary

Summer Precipitation (mm)

126 - 150
151 - 175
176 - 200
201 - 225
226 - 250
251 - 275
276 - 300
301 - 325
326 - 350
351 - 375
376 - 400



Summer 1961–1990 Baseline



Summer 2050s

FIGURE 6 Seasonal Precipitation, Baseline and 2050s[27]

Note that for legibility, winter and summer use different legends and so cannot be directly compared.

Appendix C
Definitions

Growing Degree-Days (GDD) are a measure of heat accumulation, and represent the cumulative number of degrees that the average daily temperature is above a base temperature of 5 degrees, for all days of the year.

Frost Free Days (FFD) are the number of days the temperature is above freezing.

Frost Free Period (FFP) is the consecutive number of days between first frost in fall and last frost in spring.

Heating Degree-Days are a measure of energy demand, and represent the cumulative number of degrees that the average daily temperature is below a base temperature of 18 degrees (when heating is required), for all days of the year.

Cooling Degree-Days represent the cumulative number of degrees above a base temperature of 18 degrees (when cooling is required), and is the opposite of Heating Degree-Days.

Appendix D
Adaptive Management of Climate Change Impacts

Climate change adaptation decision-making is an inherently complex task that requires ongoing learning and reflection to adjust to changing information, events and conditions. As learning progresses, new solutions as well as new challenges will be identified. The following questions are provided as tools for navigating this evolving landscape and determining priorities for action.

Additional considerations when determining how to implement priority actions would include:

- Barriers (e.g., legislation, lack of working relationships)
- Assets/Enablers (e.g., leadership, integrating into existing plans/programs)
- Implementation costs
- Operation and maintenance costs
- Financing and resources
- Timeframe

TABLE 4 Developing & Prioritizing Adaptation Actions

Effectiveness	To what degree does this action reduce risk/vulnerability, and/or enhance resilience?
Adaptability	Can this action (and resources dedicated to it) be changed or redirected as conditions change?
Urgency	When does action need to be taken on this issue, in order to be effective by the time an impact is projected to occur?
Gaps & Assets	How does this action address identified gaps or barriers? How can it build on existing assets and resources?
Co-benefits ("no-regrets")	What other benefits would this action have, even if climate change impacts do not occur as projected?
Consequences	What could be the unintended and/or undesirable effects of taking this action? Can these be avoided or mitigated?
Extent	Do the benefits apply broadly in the region, or to specific individuals?
Relevance	Does this action have the support of the agricultural community?

Endnotes

1 Crawford, Erica and Emily MacNair. *BC Agriculture Climate Change Adaptation Risk & Opportunity Assessment.* BC Agriculture & Food Climate Action Initiative. March 2012. *http://www.bcagclimateaction.ca*

2 Peace River Regional District: Our History *http://prrd.bc.ca/about/*

3 Valentine, K.W.G., Sprout, P.N., Baker, T.E., Lawkulich, L.M. (Eds.) 1978. *The Soil Landscapes of British Columbia. BC Ministry of Environment. Schaefer, D.G.* "The Environmental Factors: 1.2 Climate" *http://www.env.gov.bc.ca/soils/landscape/1.2climate.html*

4 British Columbia Agriculture in the Classroom Foundation. 2008. *Grow BC: A Guide to BC's Agriculture Resources*, p. 9. *http://www.aitc.ca/bc/uploads/growbc/1_intro.pdf*

5 British Columbia Agriculture in the Classroom Foundation. 2008. *Grow BC: A Guide to BC's Agriculture Resources*, p. 9. *http://www.aitc.ca/bc/uploads/growbc/1_intro.pdf*

6 British Columbia Agriculture in the Classroom Foundation. 2008. *Grow BC: A Guide to BC's Agriculture Resources*, p. 9. *http://www.aitc.ca/bc/uploads/growbc/1_intro.pdf*

7 Statistics Canada. 2011 Census of Agriculture: 2011 Farm and farm operator data. *http://www29.statcan.gc.ca/ceag-web/eng/community-agriculture-profile-profil-agricole?geoId=5908000006dataType=1*

8 Statistics Canada. 2011 Census of Agriculture: 2011 Farm and farm operator data. *http://www29.statcan.gc.ca/ceag-web/eng/community-agriculture-profile-profil-agricole?geoId=5908000006dataType=1*

9 North Peace Economic Development Commission. Key Sectors: Agriculture. *http://www.npedc.ca/ key-sectors/agriculture*

10 Statistics Canada. 2011 Census of Agriculture: 2011 Farm and farm operator data. *http://www29.statcan.gc.ca/ceag-web/eng/community-agriculture-profile-profil-agricole?geoId=5908000006dataType=1*

11 Statistics Canada. 2011 Census of Agriculture: Highlights and Analysis. *http://www.statcan.gc.ca/pub/95-640-x/2012002/prov/59-eng.htm*

12 Peace River Regional District Agricultural Advisory Committee Terms of Reference. *http://http://www.prrd.bc.ca/documents/Ad_Member-TOR_2011.pdf*

13 *http://www.pacificclimate.org*

14 (*http://pacificclimate.org/tools-and-data/plan2adapt*. In the graphs, the black line indicates the midpoint of all model runs, shading indicates the range.

15 For more explanation of model outputs and ranges, see *http://www.plan2adapt.ca*, and the accompanying technical report to this document.

16 Data from Wang, T., A. Hamann, D. L. Spittlehouse, and T. Q. Murdock, 2012: ClimateWNA—High-Resolution Spatial Climate Data for Western North America. *Journal of Applied Meteorology and Climatology*, 51, 16–29, doi:10.1175/JAMC-D-11-043.1.

17 Zwiers, F., M. Schnorbus, G. Maruszeczka. *Hydrologic Impacts of Climate Change on BC Water Resources: Summary Report for the Campbell, Columbia and Peace River Watersheds.* July 2011. *http://pacificclimate.org/sites/default/files/publications/Zwiers.HydroImpactsSummary-CampbellPeaceColumbia.Jul2011-SCREEN.pdf*

18 For more detailed information on the risk analysis process, see the accompanying technical report.

19 *http://www.dawsoncreek.ca/cityhall/departments/water/watershed/vision-priorities-and-actions-for-integrated-watershed-stewardship/*

20 *http://geoweb.bcogc.ca/apps/newt/newt.html*

21 *http://www.livingwatersmart.ca/drought/response.html*

22 The term "runoff" includes any water that runs across the surface of the land, including snowmelt, regular precipitation and extreme rainfall events.

23 Crawford, Erica and Emily MacNair. *BC Agriculture Climate Change Adaptation Risk & Opportunity Assessment: Executive Summary.* BC Agriculture & Food Climate Action Initiative. March 2012. *http://www.bcagclimateaction.ca/wp/wp-content/media/AdaptROseries-ExecSummary.pdf*

24 Prairie Pest Monitoring Network: *http://www.westernforum.org/IPMNMain.html*

25 These details apply to completing this specific action only, not to actions that may develop as a result. For example, if the action is to conduct a feasibility study, the details do not include what would be necessary to implement the preferred options identified in the study.

26 Data from Wang, T., A. Hamann, D. L. Spittlehouse, and T. Q. Murdock, 2012: ClimateWNA—High-Resolution Spatial Climate Data for Western North America. *Journal of Applied Meteorology and Climatology*, 51, 16–29, doi:10.1175/JAMC-D-11-043.1.

27 Data from Wang, T., A. Hamann, D. L. Spittlehouse, and T. Q. Murdock, 2012: ClimateWNA—High-Resolution Spatial Climate Data for Western North America. *Journal of Applied Meteorology and Climatology*, 51, 16–29, doi:10.1175/JAMC-D-11-043.1.